U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-261 160

Disposal of Dilute Pesticide Solutions

Environmental Protection Agency, Washington, D C

1976

BIBLIOGRAPHIC DATA SHEET	1. Report No. EPA/530/SW-519	2.	3. Recipient's Accession No.
4. Title and Subtitle Disposal of dilute pesticide solutions			5. Report Date June 1976 6.
7. Author(s) Harold R. Day			8. Performing Organization Rept. No.
9. Performing Organization Name and Address			10. Project/Task/Work Unit No. 11. Contract/Grant No.
12. Sponsoring Organization Name and Address U.S. Environmental Protection Agency Office of Solid Waste Management Programs			13. Type of Report & Period Covered 14.

15. Supplementary Notes
A current report on solid waste management

16. Abstracts

This paper draws together current information on the subject of disposal of excess dilute pesticide solutions.

17. Key Words and Document Analysis. 17a. Descriptors

17b. Identifiers/Open-Ended Terms

17c. COSATI Field Group

18. Availability Statement	19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages 24
	20. Security Class (This Page UNCLASSIFIED	22. Price 3.50

FORM NTIS-35 (REV. 10-73) ENDORSED BY ANSI AND UNESCO. THIS FORM MAY BE REPRODUCED USCOMM-DC 8265-P74

349096

EPA/530/SW-519
JUNE 1976

PB 261 160

disposal of dilute pesticide solutions

Environmental Protection Agency
Library Systems Branch, Room 2903
401 M Street, S.W.
Washington, D.C. 20460

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INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

An environmental protection publication (SW-519) in the solid waste management series. Mention of commercial products does not constitute endorsement by the U.S. Government. Editing and technical content of this report were the responsibilities of the Hazardous Waste Management Division of the Office of Solid Waste Management Programs.

Single copies of this publication are available from Solid Waste Information, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.

DISPOSAL OF DILUTE PESTICIDE SOLUTIONS

This report (SW-519) was prepared
by Harold R. Day

U.S. ENVIRONMENTAL PROTECTION AGENCY

1976

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Summary

Disposal of dilute pesticide solutions has, in the past, been addressed only in a general way. This report seeks to highlight the problem, identify sources of dilute solutions, describe current disposal practices, and consider factors which influence a choice among them.

These dilute solutions are generated by container rinsing, equipment washing, water from pesticide fire-fighting operations, spill clean-ups, and drum reconditioning operations. If disposed of carelessly, the contained pesticides can build up to toxic levels in soils, deactivate sewage treatment plants, etc..

Nine disposal methods currently in use have been identified and are discussed. These methods together with their characteristics are summarized in Table 1.

Incineration and batch biodegradation are limited by high cost, complexity, and low availability. For these reasons, they are generally restricted to treating process waste from manufacturing operations.

Photodecomposition and chemical degradation can be effective under correct conditions, but neither provides complete assurance of degradation for all pesticides and their degradation products. Lagooning is one method used principally by manufacturers to provide light for photo-decomposition to occur. Chemical degradation requires specific reactants and procedures for each pesticide, but reaction products also must be disposed of safely.

Soil injection and gravel-filled pits are primarily biodegradation methods. Given enough time, organic pesticides degrade to innocuous products.

However, the conditions needed for optimum decomposition of all pesticides and their metabolites are extremely variable and not well defined. A potential for water contamination through leakage or leaching from a disposal site exists unless its location and method of operation will reduce mobility, avoid contact with groundwater, and promote biodegradation. Because no pretreatment is needed, this method is low cost.

Long term storage in special land disposal sites offers a last resort to the disposer. In addition to being costly, this option may not lead to degradation of the pesticide, but merely isolate it from the environment. Special land disposal sites are generally unavailable and user fees may be high; however, for some pesticide solutions, particularly the inorganic and heavy metal types, this option may be the best answer.

Whenever possible, use of dilute solutions as a diluent for making up spray mixtures, is the most reliable and desirable method for disposal. Other methods discussed here are potentially valuable and should be explored. The choice of method will depend on the nature of the pesticide, the concentration, local disposal costs, and destruction assurance. The reliability, safety, and disposal parameters for dilute pesticide solutions are the subject of current studies.

TABLE 1
SUMMARY OF CHARACTERISTICS OF DISPOSAL METHODS
FOR DILUTE PESTICIDE SOLUTIONS

Method	Cost	Availability	Ease of Method	Environmental Hazards and Comments
Use as diluent in spray tank	None	High	Easy	None(if used according to label)
Incineration	High	Low	Moderately, difficult	None(if incinerator is adequate)
Soil Injection	Low	High	Easy	Minimal(at low rates); requires variable time for destruction, and may restrict crop rotation. Water contamination possible at improper sites.
Photodecomposition	None	High	Easy	Unreliable and generally incomplete degradation. Soil erosion may transport pesticides to surface waters.
Chemical degradation	Moderate	Variable	Moderate	Chemical method must be specific for the pesticide in question. Reaction may not be complete. Disposal of reaction products necessary.
Batch Biodegradation	High	Low	Difficult, complex	Not generally available; too complex for present general use.
Disposal pits	Moderate	Low	Easy	May be more effective than soil injection. May contaminate ground or surface water if not constructed or sited properly.
Special landfills	Moderate	Low	Moderate	May not degrade pesticides; landfills may not accept liquids.
Storage	Moderate	High	Easy	Merely delays disposal.

I. Introduction

This paper draws together current information on the subject of disposal of excess dilute pesticide solutions. Such solutions are comprised of unused spray, container rinsate, equipment washings, spill clean-ups, etc., and are defined as equal to or less than the recommended application concentration. This effort seeks to identify the sources of these solutions, current disposal practices, environmental hazards, and costs of disposal methods available. Federal regulatory efforts regarding pesticide disposal and current research on disposal methods are briefly summarized.

This paper reflects the current state-of-the-art and has been gathered from sources within and outside the U.S. Environmental Protection Agency (EPA). Information presented is intended for information only, and should not be construed as Agency policy.

II. Identification of Sources

There are five major sources of dilute pesticide solutions requiring disposal:

A. Container Rinsate

Residues from rinsing of noncombustible pesticide containers are a large source of excess pesticide solutions. It has been estimated that farmers used 630 million pounds of pesticides and 20 million noncombustible containers in 1966, the latest estimates available.[1] Current EPA and industry recommendations call for triple-rinsing of such containers prior to disposal. The procedure is to make three successive rinses each with a volume of the normal diluent equal to 10 percent of the container volume. Assuming that all applicators rinsed their 1-, 5-, 30-, and 55-gallon containers in 1966, 6 million gallons of solution containing some pesticide would have been generated.

With current pesticide use in this country estimated at about 1 billion pounds, the number of pesticide containers has probably increased significantly.

In real practice, few applicators rinse their containers prior to disposal. In a recent survey of Iowa cooperatives, for example, it was estimated that only five percent of the applicators did so.[1] In these cases, the most common method of rinse disposal was to drain to the soil surface.

In recent years, through the efforts of EPA,[2] the U.S. Department of Agriculture (USDA), the National Agricultural Chemicals Association (NACA), the Western Agricultural Chemcals Association (WACA), and some container reconditioners, the applicator has been urged to triple-rinse containers so they will be safer to handle for reuse, recycling, or disposal. Only a very small amount of pesticide residue remains within the containers which are triple-rinsed immediately after being emptied. Hence triple-rinsed containers are considered acceptable for disposal in a sanitary landfill. Applicators are being told it is economically advantageous to rinse containers; all the pesticide is utilized and the container can be sold more easily or disposed of in a sanitary landfill. Some container recondtioners will not take unrinsed containers.

Other recent developments of a regulatory nature will promote triple-rinsing. State laws may require it. New label directions will require it as party of the reregistration process, and certification training will increase the applicator's awareness and stress the advantages to be gained.

B. Equipment Washing

Another source of dilute pesticide solution is the washing or rinsing generally with water, of application equipment including spray tanks, mixing tanks, holding tanks, trucks, and airplanes. The volume generated is difficult to estimate because rinsing practices and equipment differ with each applicator. One source has estimated that aerial applicators in the United States use 100 million gallons of water for washing per year and another 2,500 custom applicators use about 6 million gallons of water.[3] Various estimates indicate that about a million farmers are users of pesticides; most generate waste water containing some pesticide in washing out their application equipment. According to the Iowa survey, most farmers allow the rinsate to drain on to the soil surface.

C. Water from Fires

An uncommon but real problem which can arise is a fire associated with stored pesticides. Water in large volumes from a firefighting operation becomes contaminated after contact with uncombusted or partially combusted pesticides. Recent cases of such fires in Minnesota and West Virginia have highlighted this potential source of large volumes of water containing pesticide.[4,5] In the Minnesota case, 40,000 gallons of contaminated water were recovered. The disposal was complicated because many different pesticides were present, each with its own hazards and degradation characteristics. In some cases absorbents can be used to hold the waste, but then such materials will need disposal. The West Virginia case generated 750,000 gallons of water which was sealed at the site with concrete.

D. Pesticide Spills

Spills of pesticide often demand quick action, particularly if the pesticide is highly toxic. Applications are made of lime, absorbents, or other chemicals including liberal amounts of water.[6] Contained spills often are cleaned up, and residues and solutions placed in containers for disposal. Between 1971 and 1973, 35 spill incidents involving pesticides were reported to EPA.

E. Reconditioning Operations

A drum reconditioner uses chemical rinses, fire, shot blasting, and special machinery to clean and straighten old steel drums for reuse, including some which formerly contained pesticides. The reconditioner usually first deheads the drums and washes the interior prior to burn-out. It is estimated[7] that about 5 million pesticide drums are reconditioned per year requiring 5 million gallons of water. This wash water, containing some pesticide and other chemicals, is commonly disposed of via the sewer system. However, the Federal Water Pollution Control Act regulations will limit this practice and Federal Insecticide, Fungicide and Rodenticide Act, as amended, regulations[8] will prohibit it. Therefore, safe alternatives will have to be found for disposal of these solutions.

III. Potential Impacts of Improper Disposal

Improper disposal of dilute pesticide solutions can present a hazard to man, livestock, crops, and the environment. Dilute solutions have been shown to result in fish kills and destruction of other aquatic fauna.[9]

Contamination of surface water by directly emptying rinsate into ponds, lakes, and rivers could result in a concentration of pesticide lethal to fish and other aquatic life.

Indiscriminate dumping in soil could indirectly contaminate wells, water supplies, and flora in an area. Soil microorganisms could also be adversely affected. Such contamination can be difficult and expensive to correct.

Pesticides which are persistent (resisting degradation) could accumulate in soil and serve as a reservoir for chronic contamination. Additionally, metabolites of pesticides can be as toxic as the pesticide and resist degradation. These factors emphasize the need for great care in disposal to avoid polluting surface and subsurface waters.

IV. Current Disposal Practices

A. Use as Diluent

Using dilute pesticide solutions as a diluent for spray mixtures is the most economical, easiest, and most desirable disposal method. With this practice, the material is utilized for its original intended purpose. It has long been recommended by Government and industry authorities, and assures that the pesticide is used according to label directions. Economically, the applicator benefits because he is able to utilize the quantity of pesticide that normally remains in the container after draining (a cup or more; enough for 1/2 acre in some cases). The rinsed container can then be recycled, reused, or scrapped and is safer to handle. Costly methods of disposal are avoided since this preferred disposal method can be accomplished on-site where the spray mix is prepared.

B. Holding Tanks, Disposal Pits, and Dry Wells

Methods of disposal utilizing a receptacle in the ground have been used by some applicators for pesticide solutions. In some cases[10], a dry well filled with aggregate rock is used. The rinsate is allowed to drain from equipment, flow over aggregate, and eventually seep into the soil. A variation of this is a concrete-lined pit filled with stones, gravel, etc. The spraying equipment is placed directly over the rocks and rinsed. The rinsate is held in the pit, and the water evaporates. Biodegradation may also take place, but no firm evidence of how or at what rate this process occurs is available. Buried septic tanks and leaching fields are also used. Lagooning is less desirable because volatile pesticides are exposed on the surface. In this method, rinsate is stored in an impoundment and allowed to evaporate; some degradation (by photolysis) may take place.

None of these methods have been shown to be completely reliable or safe. Concentration by evaporation can lead to dangerously potent residues. Holding tanks and pits may contaminate subsurface water, and lagooning exposes the environment directly to pesticide wastes. More testing of these methods is needed to establish parameters for biodegradation by these methods.

C. Soil Injection

Injection of dilute organic pesticide solutions by ordinary farm implements (plows, harrows, etc.) beneath the surface of the soil into the plow layer takes advantage of the biodegradation ability of soil microorganisms. If the concentration is dilute and spread over a large area, degradation of

many organic pesticides occurs rapidly. Soil microbes such as fungi and bacteria can be acclimated to use toxic organic substrates as energy sources. The variables affecting this process are difficult to measure and quantify; soil moisture, organic matter content, base exchange capacity, and temperature are all important to the biodegradation process. Further, a mixture of pesticides can effectively reduce a soil micro-flora population. More hard data are needed to obtain a clearer picture of the variables involved in soil degradation. Potentially, the soil injection method is the least expensive option open to applicators. No special equipment is needed; no transportation costs are incurred. The most desirable fact is that many organic pesticides are eventually destroyed, although the time required will vary with the conditions and the chemical characteristics of the pesticide.

D. Chemical Detoxification

Dilute pesticide solutions also can be degraded chemically, Organophosphates, carbamates, and other pesticide classes are susceptible to chemical action such as acid or alkaline hydrolysis and chemical oxidation or reduction. Most pesticides can be degraded chemically but many require exotic reactants and conditions.

The problems encountered in chemical degradation are two-fold. First, each pesticide possesses specific chemical characteristics, and a chemical method must be specific to it. Edgewood Arsenal reports that no universal chemical is effective against all pesticides . A second problem is that chemical action is not complete, thereby leaving unreacted pesticide. In some cases, reaction byproducts formed are as hazardous as the original pesticide.

Pursuant to FIFRA registration and label regulations, pesticide producers will be asked to find simple methods for disposal of their pesticides, and put appropriate directions on the label of the container. In some cases, where chemical methods are dangerous (e.g., where highly toxic products are formed or dangerous reactants and conditions are used), specific warnings also should be made.

E. Incineration

Destruction of dilute organic pesticide solutions by incineration is an effective method if sufficiently high temperatures and suitable dwell times are used. [12] Also, adequate emmission controls (scrubbers, etc.) must be present. The largest drawback to this method is the large expenditure of energy needed to drive off the solvent (commonly water). Few incinerators[13] in this country are capable of meeting the stringent requirements of a pesticide incinerator (1000 C, 2 seconds dwell-time), and their availability to most applicators is low.

F. Photodecomposition

Studies have shown that some pesticides exposed to light may be degraded or altered. When placed on the soil surface or in a lagoon, photodegradation reactions produce materials which are undefined in many cases as well as reactions which often are incomplete. However, in some cases (e.g., atrazine), it may be a desirable first step before soil degradation.

G. Batch Biodegradation

Biological degradation of pesticides in solution has been the subject of previous investigations. Results indicate that Parathion and 2,4-D can be completely degraded in controlled culture media. Major drawbacks

are slowness, expense, and complexity of the system. Cultures of microorganisms, which can produce enzymes that degrade pesticides, are subject to contamination and mutation limiting their activity. [14,15] The cultures must be isloated and maintained; generally, only one pesticide can be degraded at a time with a specific microorganism. Expense and complexity has restricted this method to laboratory experimental units and pesticide production and formulation plants.

H. Special Land Disposal Sites

Dilute pesticide solutions may be disposed of in a land disposal site which is designed and approved to accept hazardous wastes. Such sites are designed to avoid groundwater contamination, are secure, and any leachate generated is confined to the site unless it is subsequently detoxified.

A common method used by drum reconditioners is to place old containers filled with rinsate in a separate part of a disposal site and surround them with cover material. As the containers corrode, the rinsate is absorbed by the ground cover[16]; however, little is known about the eventual fate of the pesticide, and many disposal site operators, as well as State and local officials, are reluctant to permit the practice. Studies of leachate from these specific areas of disposal site would yield useful data.

V. Economic Considerations

Although improper disposal of pesticide solutions constitutes a threat to man, livestock, crops, land and water, applicators, faced with the disposal of dilute pesticide solutions, will seek the least expensive

and most convenient method available. Use as a diluent is the preferred and least cost method. The pesticide saved is worth (on the average) about one dollar per drum, and the applicator does not have to pay disposal costs.

Container rinsate, water from fires, and water from spills which are difficult to recover and may be contaminated are usually buried or allowed to drain to the ground. While inexpensive initially (only the disposer's time is considered) and convenient, this method can be hazardous and costly in the long term because of possible environmental damage requiring an expensive cleanup.

Other methods such as incineration (about $75-100/ton), chemical degradation ($50-100/ton), and special landfill disposal (about $30-50/ton) are more expensive, and also may not be available to the disposer. Some landfills will not accept liquids.

Soil injection and disposal pit costs are difficult to estimate. A concrete-lined disposal pit can be constructed for about $4500, and may last for 5 to 10 years depending on quantities disposed. Unlined pits cost less. Soil injection can be accomplished with ordinary equipment at variable costs, ranging from $10 to 20 per hour; typically, not more than 15 to 20 minutes would be required to inject one day's accumulation or rinsate.

VI. Regulations

Over the past 2 years Federal regulatory effort relating to pesticide disposal have been made under the authority of FIFRA, as amended.

A. Disposal Regulations and Recommended Procedures

On May 1, 1974, EPA published "Recommended Procedures for Disposal and Storage of Pesticide and Pesticide Containers"[2]. The disposal of

dilute pesticide solutions is addressed in a general way; the same procedures that apply for pesticides are recommended for dilute solutions. The procedures state that pesticide waste should be disposed (on a priority basis) by: use as a diluent in the spray tank, incineration (organics only), emplacement in a specially designated landfill, soil injection with EPA Regional office guidance, chemical degradation, or storage. These options are regulatory for Federal agencies, but not for the public.

On October 15, 1974, EPA proposed prohibitionary regulations[8] which would prohibit the worst acts of pesticide disposal--open dumping, open burning, water and ocean dumping--and would restrict well injection ,and storage next to food and feed. These regulations, when final, will apply to everyone; the disposal of pesticide containers, pesticides, and related residues (including dilute pesticide solutions such as excess spray solutions and rinsate) will be impacted.

B. Registration and Labeling Regulations

New regulations for registration and reregistration of pesticides require that labels on containers include instructions for disposal, and manufacturers must submit proposed labels and appropriate documentation by October, 1977. To comply, companies will be forced to supply information on how to dispose of the specific pesticide, the container, and the residues thereof. Directions for disposal will vary with the chemical nature of the pesticide and the size and type of container. Open dumping, water contamination, and food/feed contamination will be prohibited in all cases; triple

rinsing (or equivalent) will be a common requirement. Disposal in approved landfills will be required if the waste pesticides, rinsate, or containers cannot be disposed of otherwise.

VII. Current Studies on Rinsate Disposal

A. Chemical Degradation

Currently, EPA has a contract with TRW, Systems Group,Inc.,to gather information from the literature and pesticide manufacturers on chemical disposal of 20 widely-used pesticides. The report will discuss the results of reacting pesticides with common chemicals, such as caustic soda and hypochlorite, and identify those products that applicators can safely degrade. Equally important will be the identification of products that can be safely handled only by experts. The output will be in language and terms that can be readily understood by applicators, and will furnish basic guidance and precautions to be observed.

B. Soil Injection Studies

Oregon State University (OSU) recently completed an EPA-sponsored study on the effectiveness of triple-rinsing and residue disposal.[17] The soil injection study utilized a pesticide manufacturing waste (mainly 2,4-dichlorophenol), and the results are indirectly applicable to soil injection of dilute pesticide solutions. The work indicated that the method is more effective when low rates (500 pounds per acre or less) are injected and sufficient time (18 months or more) is allowed for degradation to occur.

C. Incineration

Midwest Research Institute (MRI) recently completed a study[12] on combustion of pesticides. The study shows that high temperatures (1000 C) over sufficient time (2 seconds) effectively decompose organic pesticides and destroy intermediate products formed at lower temperatures. Adequate emission control devices must be present to prevent release of hazardous combustion products (e.g., HCl) to the environment and to prevent damage to equipment. Limiting factors are temperature, time, excess air, and turbulence.

D. Filtration Studies

OSU, as part of their final report, included a study on deactivation of dilute pesticide solutions by filtration. Preliminary results indicate that activated carbon, dried sewage sludge, pine bark dust, and synthetic resins can be used to reduce pesticide concentrations in aqueous solutions to one part per million or less. Major advantages are transfer of contaminants to a solid phase and volume reduction. Filtration material can be disposed of by regeneration, incineration, by burial in a designated landfill, or by soil incorporation.[18] None of these filtration methods has been investigated in detail.

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SW-519

☆ U.S. GOVERNMENT PRINTING OFFICE 1976— 675-55/434